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Fig. 1 - 2a

(54) Abstract Title
An intake system for an internal combustion engine having a swirl valve and a exhaust backflow valve

(57) An intake port 20 forming part of an intake system for an i.c. engine has a swirl control valve 22 and a non-return valve 24 mounted within it. The swirl control valve 22 partially obstructs the intake air flow to improve mixture preparation. The non-return valve 24 is orientated in a direction which allows gas to flow only from the combustion chamber into the intake port 20 so that the obstruction presented to the back flow of internal exhaust gas recirculation (EGR) gases by the swirl control valve 22 during valve overlap period is avoided without interference to the operation of the swirl control valve 22. Preferably the non-return valve 24 is incorporated into the swirl control valve 22 in the form of a flap.

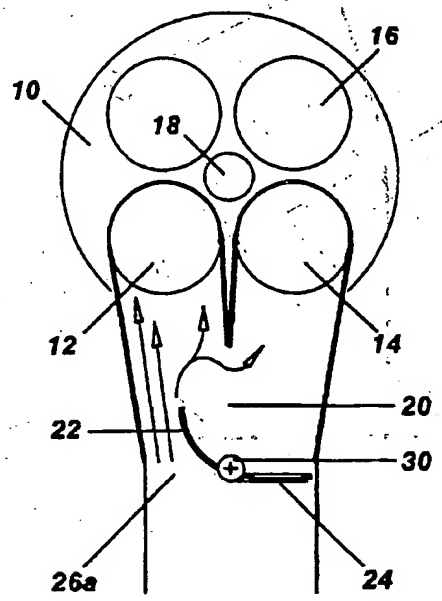

Fig.1

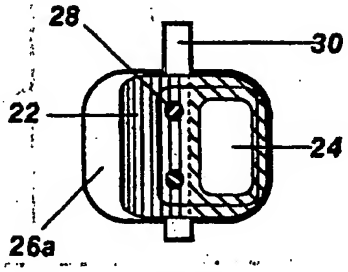

Fig.1a

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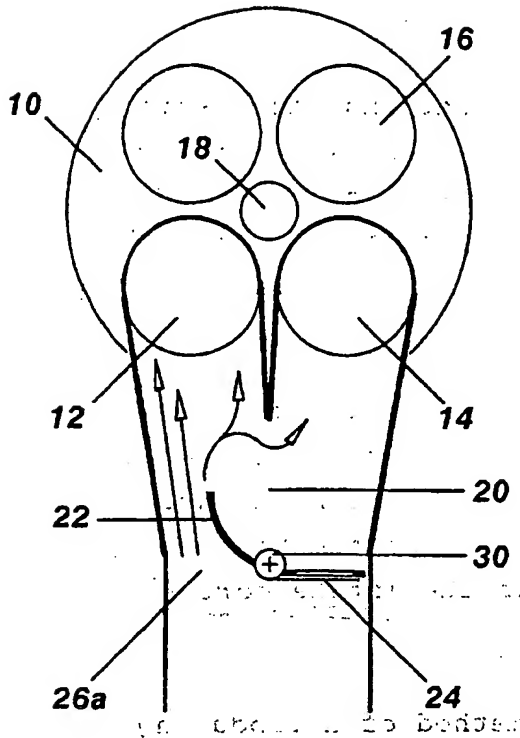

Fig.1

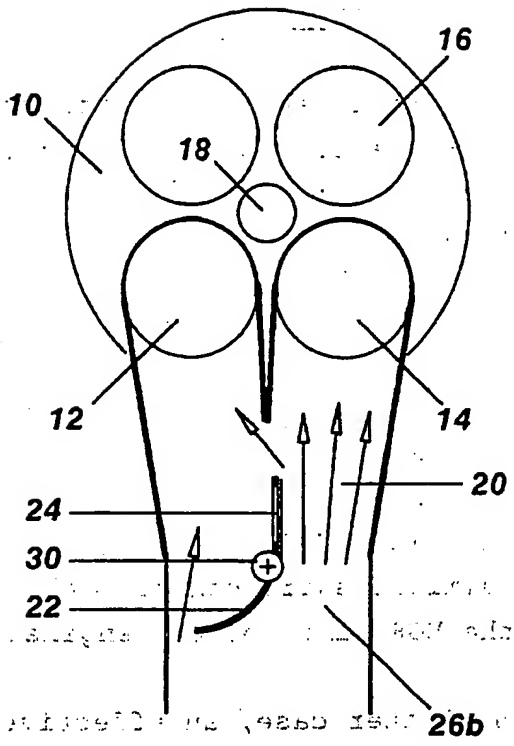

Fig.2

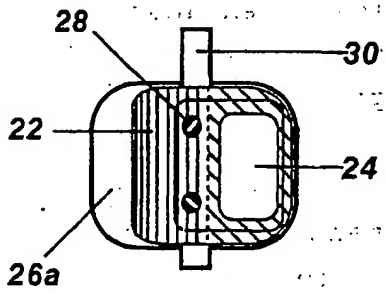

Fig.1a

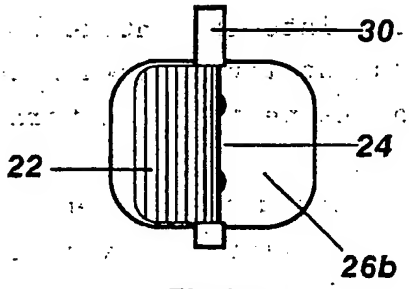

Fig.2a

Engine Intake System

Field of the invention

The present invention relates to an internal combustion engine having a swirl control valve in each intake port for partially obstructing the gas flow under certain operating conditions in order to improve mixture preparation.

Background of the invention

In lean burn engines, it is has been proposed to provide a swirl control valve in the intake port to increase the lean burn limit of the engine. In engines with exhaust gas recirculation (EGR), it has also been proposed to provide a similar swirl control valve in the intake port to increase the EGR limit of the engine.

In the latter case, an effective method of introducing EGR to the engine is to increase the valve overlap of the engine by means of a variable valve timing system. In particular, with variable intake valve timing where the opening timing of the intake valve can be advanced deep into the exhaust stroke of the engine, a back flow of exhaust gases is forced into the intake port during the valve overlap period and later drawn into the engine cylinder during the intake period as internal EGR.

A problem encountered when the above-mentioned swirl control valve and variable valve timing are used in combination in that the swirl control valve would cause a restriction to the back flow of exhaust gases into the intake part during the valve overlap period, therefore reducing the amount of internal EGR that can be achieved with variable valve timing.

Summary of the invention

In order to mitigate the above problem, the present invention provides an engine having an intake port containing a swirl control valve for partially obstructing the intake air flow in order to improve mixture preparation, and a non-return valve mounted in the intake port and oriented in a direction to allow gas flow only from the combustion chamber into the intake port, thereby avoiding the obstruction presented to the back flow of exhaust gases by the swirl control valve during the valve overlap period of each engine operating cycle without interfering with the operation of the swirl control valve in the direction of forward flow during the intake period.

In the invention, the presence of the non-return valve does not affect the performance of the swirl control valve in increasing the lean burn and EGR limits, but the amount of internal EGR that can be achieved with variable valve timing is no longer restricted by the swirl control valve.

The non-return valve may be physically separate from the swirl control valve and mounted in parallel with it but it is preferred for the non-return valve to be incorporated within and to move with the butterfly or diverter element of the swirl control valve. This makes for a more compact design in that no modification is required to the intake system and the invention can be implemented by simply changing the diverter element of the swirl control valve.

Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a combustion chamber having an intake system fitted with a swirl control valve embodying the invention,

Figure 1a is a view of the intake system of Figure 1 looking into the intake port at the diverter element of the swirl control valve, and

Figures 2 and 2a are views generally similar to Figures 1 and 1a respectively, showing the diverter element of the swirl control valve in an alternative position.

Detailed description of the preferred embodiments

The drawing show a combustion chamber 10 having two intake valves 12 and 14, two exhaust valves 16, and a spark plug 18. The intake valves 12 and 14 are supplied with intake air by a siamesed intake port 20 containing a swirl control valve that consists of a butterfly-like flow diverter element 22 pivotable about a spindle 30 the axis of which is normal to the plane of the paper. The diverter element 22 is shown in Figure 1 in one end-position suitable for low load operation in which the intake air is constrained to flow through a narrow passage 26a towards the valve 12 thereby increasing its velocity and directing it to enter the combustion chamber tangentially as represented by the arrows in order to increase swirl. In its other end-position shown in Figure 2, the diverter element 22 allows unrestricted flow towards the valve 14 whilst still permitting some flow towards the valve 12. The air intake is therefore less obstructed for high load operation.

As so far described, the intake system is known per se. The disadvantage encounter with such a system is that the diverter element 22 obstructs flow in both directions and if special steps are taken to enhance internal EGR, such as altering the valve timing, then the swirl control valve interferes with the back flow of EGR gases into the intake port.

To avoid this problem the preferred embodiment of the present invention includes a non-return valve built into the diverter element 22 of the swirl control valve. As seen in Figure 1a, the non-return valve consists of a flexible closure flap 24 held by screws 28 on the spindle 30 of the diverter element 22 and biased by its own resilience to close an opening cut out of the diverter element 22. In the forward direction of gas flow, i.e. towards the combustion chamber, the valve is closed not only by the resilience of the flap 24, but also by the air pressure across the diverter element 22. The presence of the non-return valve does not therefore affect the function of the swirl control valve in any of its positions.

When the intake valve opening time is advanced to extend the valve overlap period deep into the exhaust stroke of the engine, then a back flow of exhaust gases entering the intake system will occur creating a pressure across the non-return valve that is sufficient to raise the flap 24 off its seat, allowing the gases to enter freely into the intake system. There will be a minimal drop in pressure across the swirl control valve to overcome the natural resilience of the flap 24.

The non-return valve is most preferably incorporated into the diverter element 22 of the swirl control valve as this simplifies its implementation, but it will be appreciated that its function could be performed by a separate non-return valve mounted in a passage bypassing the swirl control valve.

CLAIMS

1. An engine having an intake port containing a swirl control valve for partially obstructing the intake air flow in order to improve mixture preparation, and a non-return valve mounted in the intake port and oriented in a direction to allow gas flow only from the combustion chamber into the intake port, thereby avoiding the obstruction presented to the back flow of exhaust gases by the swirl control valve during the valve overlap period of each engine operating cycle without interfering with the operation of the swirl control valve in the direction of forward flow during the intake period.

2. An engine as claimed in claim 1, wherein the non-return valve is incorporated within the diverter element of the swirl control valve.

3. An engine having an intake port containing a swirl control valve for partially obstructing the intake air flow in order to improve mixture preparation, constructed and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

The Patent Office

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Application No: GB 9812749.1 **Examiner:** David Glover
Claims searched: 1-3 **Date of search:** 29 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1B (B2A9A)

Int Cl (Ed.6): F02B 31/06, 31/08

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0021706 A1	(Showalter)	
A	US 4095569	(Wakita *et al*)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.